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AGRICULTURAL EXPERIMENT STATION
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Division of Dairy Husbandry
and
Western Washington Experiment Station

The Feeding Value of Dried Apple Pomace For Dairy Cows

by
J. C. Knott, R. E. Hodgson, and E. V. Ellington

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[1]In cooperation with the State Committee on the Relation of Electricity to Agriculture.
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THE FEEDING VALUE OF DRIED APPLE POMACE FOR DAIRY COWS

By J. C. Knott, R. E. Hodgson and E. V. Ellington

Introduction

Washington ranks first among all states in the production of apples. The annual crop of this state is approximately thirty-one and one-half million bushels. Most of the highest grade apples are marketed for eating apples and large quantities of the better grade apples are used for canning. It is estimated that about ten per cent of the annual crop are culls. Many of the cull apples and also some of the better grades are used for the production of vinegar and other by-products. Apple pomace is a by-product of the apple cannery and of the vinegar factory and hundreds of tons are produced annually in this state. Apple pomace from the canneries contains a greater percentage of cores and peelings than that from the vinegar factories.

Dairymen in the vicinity of factories producing apple pomace have fed this material to their cows with splendid results. In spite of this fact, large quantities are not being used.

Because of the high water content, apple pomace must be used within a short distance of the factories producing it. The drying of this by-product greatly reduces the shipping charges and almost entirely eliminates waste by spoilage. More extensive utilization of apple pomace would mean an economical source of feed for the dairyman as well as a cash return to the apple industry for a by-product that in many cases is a liability.

Review of Other Investigations

Apple pomace has been used as a feed for dairy cows for many years. Hills (1, 2, 3) from experiments with feeding wet apple pomace to dairy cows concluded that one pound of this feed was equal to from three-fourths to one pound of good corn silage.

Lindsey (4) concluded that possibly four pounds of apple pomace are equal to one pound of hay. He bases his conclusion on the use of wet apple pomace in feeding the experiment station herd, and upon a feeding experiment with two cows where the apple pomace was included in a ration with hay and grain.

Atkeson and Anderson (5) found wet apple pomace silage to be equal pound for pound to good corn silage.

Lindsey, Beals, and Archibald (6) conducted digestion experiments with sheep, and feeding experiments with dairy cattle, to determine the feeding value of dried apple pomace. The sheep digested on an average 68.5 per cent of the total dry matter. They report that the nitrogen-free extract and fiber were quite well utilized, but that the fat was rather poorly utilized and the protein was apparently not digested at all. From two feeding experiments with dairy cows, Lindsey and associates conclude that dried apple pomace is but slightly inferior to dried beet pulp or corn meal.

Walton and Bidwell (7) report experiments with both dried apple pomace and dried apple pectin pulp. In these experiments the pulp was fed soaked and was compared with both corn silage and soaked dried beet pulp. They concluded that "pound for pound of dry matter consumed the moistened apple pomace seemed to be slightly more efficient as a milk producer than good corn silage." They also concluded that "pound for pound of dry matter, pectin pulp seemed to be intermediate between good corn silage and beet pulp as a succulent feed for cows in lactation."

Holdaway (8), as a result of feeding experiments with producing dairy cows, concludes that one ton of dried beet pulp is equal in feeding value to four tons of corn silage and that one ton of dried apple pomace is equal in feeding value to three tons of corn silage.

Holdaway (9) and associates conducted three digestion experiments on four Holstein-Friesian cows. The apple pomace was fed with a basal ration consisting of a grain mixture and corn silage. Coefficients of digestibility had been previously determined on the basal ration. In the first experiment, the dried apple pomace was added to the basal ration and the coefficients obtained by trial. Due to the fact that dried apple pomace is a bulky feed, high in energy and low in protein, its addition to the basal ration widened the protein-energy ratio causing a depression of digestibility of the protein of the whole ration. As a result of this depression apparently none of the protein of the apple pomace was digested and less of the protein of the basal ration was digested than in the preliminary trial.

In the second experiment the protein in the ration was increased and slightly better results were obtained on the digestibility of that constituent in the dried apple pomace.

In the third experiment the protein of the ration was still further increased with the result that 37 per cent of the protein of the apple pomace was apparently digested.

These authors state that "The digestible coefficients found for dried apple pomace under balanced conditions are: dry matter 67 per cent, crude protein 37 per cent, ether extract 32 per cent, crude fiber 54 per cent, nitrogen-free extract 80 per cent."

The Production of the Dried Apple Pomace Used in This Investigation

The dried apple pomace used in this investigation was produced by the Olympia Canning Company at Olympia, Washington, and was a by-product of the apple canning operations of that factory. This material contained a high percentage of peelings and cores, although there was included an appreciable amount of small whole apples together with trimmings from the flesh of the peeled fruit. The apple pomace was dried in a rotary steam drier. This drier consisted of a steel cylinder. On the inside of this cylinder against the steel walls were placed closed steam coils. A steam pressure of 90 pounds was carried in the coils which gave a temperature of about 300° F. The cylinder revolved and the pomace was constantly in motion. The drying time was from one and one-half to two hours. Due to the rapid evaporation, the temperature of the pomace itself never rose above 160° F. at which point the sugars begin to break down.

The General Plan of the Investigation

The object of this investigation was to determine the digestibility and feeding value of dried apple pomace as produced in the state of Washington. The investigation consisted of one digestion experiment with three two-year-old Holstein-Friesian heifers and two double reversal feeding experiments with ten milking cows each. The first feeding experiment was conducted at the Washington Agricultural Experiment Station at Pullman, in the winter of 1930-31. The digestion experiment was conducted at the same place during the winter of 1931-32. During the winter of 1931-32, the second feeding experiment was conducted at the Western Washington Experiment Station at Puyallup.

The Digestion Experiment With Dried Apple Pomace

Animals Used: Three pure-bred Holstein-Friesian heifers were used in this digestion experiment. These heifers were two-year-olds and weighed, on an average, about 900 pounds. Animal No. 113 was in poorer condition than either of the other heifers at the start of the experiment.

Management: The experimental heifers were kept in digestion stalls shown in Figures 1, 2, and 3. They were fed twice daily at 12-hour intervals. Water was kept before them at all times. Each animal was exercised daily by walking for about 15 minutes. Weights were taken daily at the same hour throughout the experiment. An attendant was on constant watch to collect the feces.

Ration Fed: The heifers were fed solely on dried apple pomace throughout a 12-day preliminary period and a 14-day collection period. The amount of feed to be fed was based on the digestibility determined

by Holdaway and associates (9) and upon the Morrison standard for growing dairy cattle as proposed by Fitch and Lush (10). Before the start of the preliminary period, it was discovered that the experimental animals would not consume enough of the apple pomace alone to satisfy these requirements. The amount was therefore reduced to one-half of the requirements based on the above-mentioned standards and even then some of the feed was refused. In addition to the dried apple pomace and water, the animals received salt and sterilized bone flour.

Sampling the Feed: Feed enough for the entire experiment was thoroughly mixed and divided into three piles. Each individual feeding was made up of a portion from each of the three piles. These individual feedings for the entire experiment were weighed into paper sacks. After every four feedings were weighed into the sacks a small amount of the apple pomace was taken from each pile to form a composite sample for chemical analysis. The quantity of feed fed was uniform throughout both the preliminary and collection period. Refused feed was weighed and its moisture content determined.

Collecting and Sampling the Feces: The animals were under constant observation by attendants. The feces were collected as dropped and deposited in large galvanized iron cans. Once daily the feces were weighed, mixed and aliquot samples of five per cent of the day's excretion were taken. These samples were placed in air-tight containers and stored in a refrigerator at a temperature of 10° F. below zero.

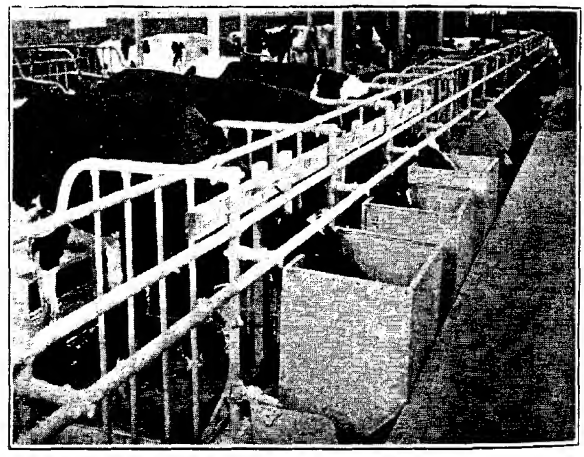

Figure 1. Front view of stall used in digestion trial, showing mangers in place.

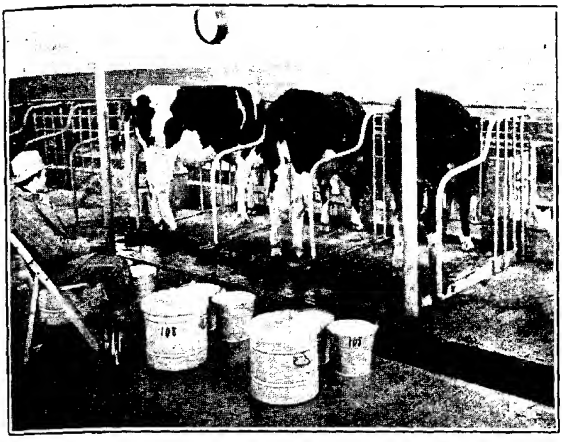

Figure 2. Rear view of stall used in digestion trial, showing containers and attendant.

Figure 3. Rear view of stalls used in digestion trial, showing heifers at rest.

The analyses* of the feed and feces were carried out by the method of the Association of Official Agricultural Chemists (11).

Results: The percentage composition of the feed and of the feces from the three experimental animals is shown in Table 1.

Table 2 shows the daily feed fed, feed refused, feed consumed, feces voided and the percentage and total dry matter of each. It will be noted that the feed consumption was rather irregular. As the sole source of the diet, the dried apple pomace was not palatable. On December 15, animal 113 voided no feces whatever. It was necessary to administer a laxative of ¾ pound of Epsom salts after which the animal apparently became normal again. Animal 110 consumed her feed more readily and completely and her defecations were more normal and regular.

Table 3 shows the daily live weights for each of the experimental animals both for the 12-day preliminary period and for the 14-day collection period. It will be noted that each of the animals lost weight quite rapidly throughout the experiment.

Table 4 shows the quantities of the nutrients ingested, voided and retained by each of the animals and the average for all three. It will be noted in each case that more protein was voided than was ingested. This was no doubt due to endogenous nitrogen and was to be expected from results of previous experiments. If sufficient protein had been added to the ration, the protein of the apple pomace would have undoubtedly been at least partially retained. In the case of each nutrient, heifer 113 showed a better utilization.

Table 1. Percentage Composition of Feed and Feces
(Dry Matter Basis)

	Dry matter	Crude protein	Crude fiber	Ether extract	Ash	Nitrogen-free extract
Dried apple pomace	88.49	4.56	14.25	6.15	2.13	72.91
Feces						
Animal No. 104	22.00	22.35	24.35	13.56	7.51	32.23
Animal No. 110	22.40	22.43	21.56	14.56	8.17	33.28
Animal No. 113	22.69	20.14	21.85	13.16	8.65	36.20

*Acknowledgment—The writers are indebted to Mr. Harold Gerritz, who did the analytical work involved in this study.

Table 2. Feed Consumed, Feces Voided and Dry Matter in the Feed and Feces

Cow No.	104				110				113			
Date	Feed Fed Grams	Feed Refused Grams	Feed Consumed Grams	Feces Voided Grams	Feed Fed Grams	Feed Refused Grams	Feed Consumed Grams	Feces Voided Grams	Feed Fed Grams	Feed Refused Grams	Feed Consumed Grams	Feces Voided Grams
December, 1931												
13	3405	.....	3405	2805	3405	.....	3405	2685	3405	.....	3405	4246
14	3405	1405	2000	3067	3405	568	2837	4252	3405	581	2824	1692
15	3405	.....	3405	5120	3405	.....	3405	4796	3405	712	2693	.....
16	3405	1219	2186	4499	3405	.....	3405	5394	3405	885	2520	432
17	3405	2627	778	2592	3405	1355	2050	4894	3405	778	2627	2381
18	3405	2864	541	1902	3405	.....	3405	3044	3405	1370	2035	930
19	3405	735	2670	1287	3405	.....	3405	2520	3405	.....	3405	2564
20	3405	877	2528	10801	3405	546	2859	3480	3405	1130	2275	3106
21	3405	.....	3405	2326	3405	.....	3405	2862	3405	1709	1696	2820
22	3405	.....	3405	2938	3405	727	2678	4304	3405	757	2648	2482
23	3405	.....	3405	4858	3405	.....	3405	2503	3405	.....	3405	2597
24	3405	878	2527	4823	3405	1142	2263	3161	3405	345	3060	3406
25	3405	.....	3405	3313	3405	.....	3405	3314	3405	.....	3405	5689
26	3405	516	2889	4487	3405	46	3359	3721	3405	691	2714	5112
14-day totals	47670	11121	36549	45097	47670	4384	43286	50930	47670	8958	38712	37457
Per cent dry matter	88.49	81.1	.....	22.00	88.49	81.9	.....	22.40	88.49	82.6		22.69
Total dry matter	42183.18	9019.13	33164.05	9921.34	42183.18	3590.50	38592.68	11408.32	42183.18	7399.31	34783.87	8498.99